Title: Optical Polarization of Light from a Sorghum Canopy Measured under both a Clear and an Overcast Sky.

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Introduction: We tested the hypothesis that the optical polarization of the light reflected by a sorghum canopy is due to a Fresnel-type redirection, by sorghum leaf surfaces, of light from an unpolarized light source, the sun or overcast sky, toward the measuring sensor. If it can be shown that the source of the polarization of the light scattered by the sorghum canopy is a first surface, Fresnel-type reflection, then removing this surface reflected light from measurements of canopy reflectance presumably would allow better insight into the biochemical processes such as photosynthesis and metabolism that occur in the interiors of sorghum canopy leaves.

Methods: We constructed a tower 5.9m tall in the center of a homogenous sorghum field. We equipped two Barnes MMR radiometers with polarization analyzers on the number 1, 3 and 7 Landsat TM wavelength bands. Positioning the radiometers atop the tower, we collected radiance data in 44 view directions on two days, one day with an overcast sky and the other, clear and sunlit. From the radiance data we calculated the linear polarization of the reflected light for each radiometer wavelength channel and view direction.

Results and Discussion: Our experimental results support our hypothesis, showing that the amplitude of the linearly polarized portion of the light reflected by the sorghum canopy varied dramatically with view azimuth direction under a point source, the sun, but the amplitude varied little with view azimuth direction under the hemispherical source, the overcast sky. Under the clear sky, the angle of polarization depended upon the angle of incidence of the sunlight on the leaf, while under the overcast sky the angle of polarization depended upon the zenith view angle. These results support a polarized radiation transport model of the canopy that is based upon a first surface, Fresnel reflection from leaves in the sorghum canopy.

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